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Damage to First-Year Conifers Under Three Livestock Grazing Intensities in Idaho

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RESEARCH SUMMARY

During the summer and fall of 1982, a study was established on National Forests in northern and central Idaho to investigate effects of livestock grazing on seedling establishment and growth. Study areas were selected in Douglas-fir/ninebark (study area 1), grand fir/clintonia (study area 2), and western redcedar/clintonia (study area 3) habitat types that represent a high potential for both forage and timber production.

Within each of the three study areas, three uniform sites were located to represent different livestock grazing intensities (light, medium, and heavy). Field observation and records on history of grazing use were used for individual site selection. Within each grazing intensity, a 0.4-ha plot was located for observation. Actual forage utilization at each of the study sites was determined at the end of the first grazing season.

All study plots were planted at a rate of 1,977 trees per hectare. Two species were planted alternately in each study area. Study areas 1 and 2 were planted in the spring of 1983; ponderosa pine and Douglas-fir were planted in area 1 and ponderosa pine and western white pine in area 2. Study area 3 was planted in the spring of 1984 to ponderosa pine and western white pine.

Frequent, periodic observations made it possible to define and quantify causes of damage and mortality to tree seedlings. Each tree was observed seven times—six times at 3-week intervals during the first growing season and one time the following spring. By determining seasonal distribution patterns of deer and elk, and timing observations around livestock turn-on and turn-off dates, accuracy in assessing the causes of damage was ensured. A damage assessment key was developed and used to record specific types of tree damage on each study area.

The intensity of livestock utilization and livestock management practices appeared to influence damage associated with livestock, wildlife, rodents, and nonanimal factors. Direct damage from livestock varied from no trees damaged on a site receiving 27 percent utilization to 5.8 percent damage on a site receiving 81 percent utilization.

Grazing intensity also influenced damage from both pocket gophers and other rodents that forage aboveground. Where cover was reduced by grazing, there appeared to be an overall decrease in the amount of aboveground damage associated with rodents. On a site receiving 36 percent utilization, rodent damage to ponderosa pine and western white pine was 51 percent and 61 percent, respectively; however, rodent damage to ponderosa pine and western white pine on the site that received 81 percent utilization was significantly less (28 percent and 26 percent, respectively).

Damage associated with deer and elk did not appear to be related to livestock grazing intensities. Where steep terrain limited livestock utilization, however, trampling damage from big-game animals was higher than the other two study areas due to the "stair steps" provided by the scalped planting sites.

The results of this study show that grazing intensity may influence the impact that animals have on first-year establishment of tree seedlings in a plantation setting. The results also indicate that through proper livestock management direct damage from livestock can be minimal. In addition, it appears that livestock grazing may decrease damage from rodents.

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INTRODUCTION

Grazing of forestland is a traditional resource use in the Northern Rocky Mountains and much of the Western United States (Tisdale 1961). These lands have potential to produce large amounts of forage in response to moderate to high precipitation (McLean 1974). As a multiple-use aspect of these lands, forage production and grazing are important and valid uses of many of these areas (Mitchell 1982). Although grazing may be of equal or greater economic importance than timber production on drier sites (Clary and others 1975), it usually has lower value than timber production on mesic and wet sites that are common in northern and central Idaho (USDA FS 1984; Eissenstat and others 1982).

A major concern of forest resource managers is the compatibility of livestock grazing with intensive forest management. The premise that grazing may damage both natural and artificial tree regeneration, as well as cause soil compaction that may interfere with tree development, is a common concern of those responsible for regenerating cutover areas (Edgerton 1971). The general consensus is that on sites more favorable for regeneration closely controlled livestock grazing may be compatible with tree establishment (Adams 1975). But on sites where regeneration is sparse or difficult to obtain, grazing is incompatible until there is an adequate stocking of trees large enough to withstand grazing (USDA FS 1982).

Although research studies are constantly adding to our knowledge of forest and range management, few studies truly integrate these values (Kingery 1983). Consequently much of the research that has been done simply reinforces the conviction that livestock use is either compatible or incompatible with intensive forest management.

A number of studies specifically address grazing impact on tree seedlings. There is a great deal of variability in research methods and study results (USDA FS 1982). Wellner (1969) stated that "the question of grazing and tree regeneration is quite inconsistent and controversial; one can get almost any answer he wishes from the literature."

To provide more definitive information on the grazing-reforestation issue, an investigation was established to determine the effects of livestock grazing on the factors that influence the establishment and growth of seedlings. The study was located on cutover lands on the Nez Perce, Clearwater, and Idaho Panhandle National Forests. The study considered: concentration of animals; duration and timing of grazing; terrain, soil, and ground vegetation; and tree species and size. This report covers findings of the first year of study, generally considered to be the most crucial period of seedling survival.

METHODS

Study Areas

Areas were selected that have a high potential for both forage production and growth of commercial timber. Study areas were located in central and northern Idaho in three different habitat types (Cooper and others 1985) to represent a wide range of conditions. The first study area was located in a *Pseudotsuga menziesii/Physocarpus malvaceus* habitat type, which reflected fairly dry and warm conditions; the second study area was located in an *Abies grandis/Clintonia uniflora* habitat type, a mesic or intermediate set of conditions; study area 3 was located in a *Thuja plicata/Clintonia uniflora* habitat type, characterized by cool, moist conditions.

Within each of these study areas, three uniform sites were located to represent different livestock grazing intensities (light, medium, and heavy). Within each grazing intensity, a 0.4-ha plot was located. Field observation and records on the history of grazing use were used to select sites within each habitat type. Actual forage utilization at each of the study sites was determined at the end of the first grazing season.

Study Area 1: Indian Springs—The Indian Springs study area is in the Squaw Creek drainage of the Slate Creek Ranger District, Nez Perce National Forest. The area is part of the Salmon River breaks, and the general topography is quite steep, with mass wasting evident. Slope of the study area ranges from 0 to 50 percent, with an average slope of approximately 25 percent.

Majority of the soils on the study area are Typic Argixerolls, fine loamy mixed frigid family, which are moderately to well drained. Due to the mass wasting and erosion in the area, some soils have a thin surface layer.

The climate for this vicinity is subhumid, with warm dry summers and cool wet winters. The majority of the precipitation falls during the winter, with July and August being the driest months. The estimated annual precipitation for the area is approximately 45 cm. The mean annual air temperature for the study site is 9 °C.

The Indian Springs study area is in the *Pseudotsuga menziesii/Physocarpus malvaceus* habitat type, *Calamagrostis rubescens* phase, as described by Cooper and others (1985). An overstory of Douglas-fir (*Pseudotsuga menziesii*

[Mirb.] Franco) and ponderosa pine (*Pinus ponderosa* Laws.) dominate the overstory community; the *Physocarpus* union characterizes the understory. High percentages of ninebark (*Physocarpus malvaceus* Greene) and oceanspray (*Holodiscus discolor* Pursh [Maxim.]) typify this union. Other shrub species occurring in lower percentages are serviceberry (*Amelanchier alnifolia* Nutt.), syringa (*Philadelphus lewisii* Pursh), baldhip rose (*Rosa gymnocarpa* Nutt.), spirea (*Spiraea betulifolia* Pall.), and common snowberry (*Symphoricarpus albus* [L.] Blake). Herbaceous species include largeleaf sandwort (*Arenaria macrophylla* Hook.), heartleaf arnica (*Arnica cordifolia* Hook.), wild strawberry (*Fragaria* spp.), and Columbia brome (*Bromus vulgaris* Hook.).

Current shrub vegetation on the area consists predominantly of ninebark, serviceberry, blueberry (*Vaccinium globulare* Rydb.) and currant (*Ribes* spp.). Herbaceous species include brodiea (*Brodiaea elegans* Hoover), houndstongue (*Cynoglossum* spp.), buckbean (*Thermopsis montana* Nutt.), pinegrass (*Calamagrostis rubescens* Buckl.), and orchardgrass (*Dactylis glomerata* L.).

Study Area 2: Tee Meadows—The Tee Meadows study area is located in the Vassar Meadow complex of the Palouse Ranger District, Clearwater National Forest. The area is part of the Musselshell Basalt Lands Subsection (Arnold 1975). The general topography of the area is fairly moderate. Elevation of this study area is 883 m.

The soils in this area are of the fragipan phase of the Andeptic Paleboralfs, medial over loamy mixed family. These soils, formed in a thick (35- to 65-cm) layer of volcanic ash, are very deep, moderately well drained, and underlain by loess. But because a fragipan exists, infiltration and permeability are slow to very slow. Available water capacity is low, and effective rooting depth is only 51 to 77 cm. Erosion potential is high when vegetation cover is removed.

The climate for this study area is subhumid to humid, with a mediterranean precipitation pattern of cool, dry summers and cool, wet winters. The annual precipitation for the area is 90 cm and the mean annual temperature is 7 °C.

The Tee Meadows study area is in the *Abies grandis/Clintonia uniflora* habitat type, *Clintonia uniflora* phase. This is one of the major habitat types of northern Idaho (Cooper and others 1985). An overstory of grand fir (*Abies grandis* [Dougl.] Lindl.) and an understory of moist-site forbs such as queencup beadlily (*Clintonia uniflora* [Schult.] Kunth), starry solomonplume (*Smilacina stellata* [L.] Desf.), sweetscented bedstraw (*Galium triflorum* Michx.), goldenthread (*Coptis occidentalis* [Nutt.] T. G.), fairybells (*Disporum hookeri* [Torr.] Nicholson), and American adenocaulon (*Adenocaulon bicolor* Hook.) dominate the potential natural community. Western thimbleberry (*Rubus parviflorus* Nutt.), baldhip rose, Utah honeysuckle (*Lonicera utahensis* Wats.), and blueberry are shrubs that are commonly found in seral plant communities of this habitat type.

The dominant species for the Tee Meadows study area were orchardgrass, timothy (*Phleum pratense* L.), elk sedge (*Carex geyeri* Boott), wild strawberry, sweetscented bedstraw, starry solomonplume, and buckbean.

Study Area 3: Hume Creek—The Hume Creek study area is located in the Hume Creek drainage of the St. Maries Ranger District, Idaho Panhandle National Forests. It is in the Central Idaho Rocky Mountains Major Land Resource Area (Austin 1972). Topography in this area is level to moderately sloped, with an average slope angle of 15 percent.

Soils in the Hume Creek study area were formed in thick loess layers over basalt terraces. These soils fall in the Reggear series (cool phase) and are classified as fine-silty, mixed Typic Fragiboralfs. The soils are primarily silt loams, grading to silty clay loams in the lower horizons, and are moderately deep with a fragipan occurring between 50 cm and 100 cm. The soils are well drained, with permeability being moderate to poor due to the fragipan. Available water capacity is low, and rooting depth is shallow. The erosion hazard on these soils increases from slight on the gentle slopes to severe on the steep slopes.

The climate in this area is characterized by a mediterranean precipitation pattern of cool, wet winters and cool, dry summers common to northern Idaho. The mean annual precipitation for the site is 69 cm. The mean annual air temperature is 8 °C.

This study area is located in a *Thuja plicata/Clintonia uniflora* habitat type, *Clintonia uniflora* phase (Cooper and others 1985). In the potential natural community western redcedar (*Thuja plicata* Donn ex D. Don) dominates the overstory, and the understory consists of the *Clintonia* union. The presence of queencup beadlily, sweetscented bedstraw, goldthread, rattlesnake plantain (*Goodyera oblongifolia* Raf.), and foamflower (*Tiarella trifoliata* L.) typifies this union. Unlike the other two sites, ponderosa pine does not occur as a seral tree species under natural conditions; however, it will grow where planted.

The predominant species present in the Hume Creek study area are western yarrow (*Achillea millefolium* L.), thistle (*Cirsium* spp.), wild strawberry, clover (*Trifolium* spp.), orchardgrass, and bluegrass (*Poa* spp.)

PLANTING PROCEDURES

During the spring of 1983 the Indian Springs study area was planted with 2-0 bareroot ponderosa pine and Douglas-fir obtained from the Forest Service nursery, Coeur d'Alene, ID. Each tree was planted in a scalped area 30 cm by 30 cm with use of a planting hoe. In addition, each tree was shaded using a 30-cm by 35-cm card on a 30-cm stake. The selected plot was planted at a rate of 1,977 trees per hectare. The two species were planted alternately, with a spacing of 6.7 m. This resulted in 28 rows consisting of 28 trees per row in each plot. Within each plot, an individual tree planter planted all of one species to insure uniformity of planting.

The Tee Meadows study area was also planted during the spring of 1983. Because Tee Meadows is cooler and wetter than Indian Springs, ponderosa pine and western white pine (*Pinus monticola* Dougl.) were planted. The same planting techniques were used at Tee Meadows as were used on the Indian Springs study site.

The Hume Creek study area was planted in the spring of 1984 to western white pine and ponderosa pine. The planting procedures were the same as on the other two study areas.

SAMPLING PROCEDURES

To avoid any edge effect of the planting, only the center of each plot was sampled. A 3-m buffer strip was defined on the outside of each plot. This resulted in 26 tree rows within each 0.4-ha plot available for sampling in the study.

To define and quantify causes of damage and mortality to tree seedlings during the first year of establishment, each tree in the study was observed seven times, six times at 3-week intervals during the first growing season and one time the following spring. Frequent, periodic observations made it possible to determine not only what caused damage but also when damage was occurring. Also, by determining seasonal distribution patterns of deer and elk, and timing observations around livestock turn-on and turn-off dates, we were able to further reduce error in observation.

A damage assessment key was developed and used to record specific types of tree damage on each site (appendix).

The following tabulation shows agent and the type of seedling damage that was observed during the first year of the study:

Nonanimal	Pocket gopher	Other rodents	Big game	Livestock
planting	browsing	browsing	browsing	browsing
drought	root removal	girdling	trampling	trampling
snow	tree removal			

Utilization by livestock was determined by use of protected and unprotected 1-m square plots. Vegetation was clipped and weighed on plots protected from grazing and compared to that obtained from grazed plots. The difference in weight was used to determine the percentage of utilization.

ANALYSIS

An analysis of variance was used to analyze the data. The influence of three different grazing intensities on the percentages of trees substantially damaged by livestock, pocket gophers, other rodents, wildlife, and unknown agents was computed for each row in the study. These percentages were transformed (square root of arc sine) and used in the analysis. At each site there were three utilization levels, with 26 tree rows per utilization level. Because conducting a true replicated study was logistically and financially prohibitive, tree rows were used in the analyses as replicates. Duncan's multiple range test was used to detect differences among the utilization means. The three tree species used in this study were analyzed separately.

RESULTS

The following results assess the impact of animal and nonanimal related factors on tree seedlings during the first 12 months of establishment. The first year of establishment is the most important in the life of a forest plantation. It is at this time that tree seedlings are most susceptible to numerous biotic and abiotic environmental factors that can cause mortality or reduced growth. These results identify the influence of livestock grazing intensity on those factors damaging first-year plantations. This is done for each of the three study areas.

Indian Springs

Grazing intensity appeared to influence the total percentage of ponderosa pine trees that were damaged in the different utilization levels at Indian Springs. The factors that most influenced tree damage and mortality were nonanimal causes, rodents other than pocket gophers, and wildlife (deer and elk). On the high-utilization site, 14.4 percent of the seedling damage was from nonanimal-related causes as compared to 4.9 percent of the seedlings damaged on the study site receiving an intermediate level of utilization (table 1). It appeared that rodents other than pocket gophers did the most damage in the low-utilization area, with no differences in percentage of damage detected between the intermediate and high levels.

The sum of these damaging agents was the largest in the low-utilization level (21.9 percent damage) and in the high-utilization level (24.4 percent damage). The fewest trees damaged were in the intermediate-utilization level.

The results for Douglas-fir were similar to those of ponderosa pine at the three different utilization levels. Wildlife caused the largest amount of damage (6.5 percent) on the low-utilization level (table 1). Nonanimal damage for Douglas-fir was higher on the heaviest grazed area (4.9 percent). Similar to ponderosa pine, the greatest damage and mortality occurred on the areas receiving light and heavy grazing intensities. Fewest trees were damaged on the intermediate-utilization level, where only 3.7 percent of the trees were damaged.

Tee Meadows

Damage and mortality to ponderosa pine were significantly different for each of the three utilization levels. Pocket gophers caused the most damage to the ponderosa pine seedlings. The greatest amount of damage occurred at the intermediate-utilization level (66.3 percent), with 51.2 percent at the light-utilization level and 28.8 percent damage at the heavy grazing intensity (table 2).

Nonanimal damage was the greatest at the low-utilization level (7.4 percent). In addition, no significant differences were found in damage to ponderosa pine among the grazing levels by livestock or wildlife.

The differences found among the three utilization levels for total damage were influenced most by pocket gophers, with the highest amount of damage occurring at the intermediate grazing intensity. Total damage was least on the high-utilization level (33.8 percent), with 72.8 percent of the trees damaged on the intermediate grazing level.

Fewer differences in damage were found with western white pine at the different grazing intensities than with ponderosa pine. The largest amount of damage to western white pine was caused by pocket gophers, with 61.2 percent damage occurring at the light grazing intensity and 63.8 percent damage at the intermediate grazing intensity.

Table 1—Percentage of trees to incur substantial damage[1] or mortality at Indian Springs site, for three forage utilization levels: low, 20 percent;[2] mid, 47 percent; high, 71 percent

Damage agent	Ponderosa pine			Douglas-fir		
	Low	Mid	High	Low	Mid	High
Nonanimal	5.1 a[3]	4.9 a	14.4 b	0.6 a	0.7 a	4.9 b
Gopher	1.8 a	1.7 a	2.5 a	2.1 a	1.7 a	4.7 a
Rodent	6.2 a	.3 a	.3 b	5.0 a	.3 b	2.6 a
Big game	7.8 a	1.7 b	5.0 ab	6.5 a	.3 b	1.4 b
Livestock	1.0 a	.6 a	2.2 a	1.2 a	.7 a	.8 a
Total	21.9 a	9.2 b	24.4 a	15.4 a	3.7 b	14.4 a

Forage utilization level

[1] Damage was determined from the overall vigor of the tree seedlings. Substantial damage percentages included tree seedlings in vigor classes 3 or 4, as described in the appendix.

[2] Actual utilization of range forage from field measurements.

[3] Different letters indicate significant differences among utilization levels. The analysis was conducted using the arc sine $\sqrt{\text{percent}}$ transformation.

Table 2—Percentage of trees to incur substantial damage[1] or mortality at Tee Meadows site, for three forage utilization levels: low, 36 percent;[2] mid, 58 percent; high, 81 percent

Damage agent	Ponderosa pine			Western white pine		
	Low	Mid	High	Low	Mid	High
Nonanimal	7.4 a[3]	2.7 b	2.7 b	2.9 a	1.3 b	1.0 b
Gopher	51.2 a	66.3 b	28.8 c	61.2 a	63.8 a	26.6 b
Big game	2.7 a	1.4 a	.3 a	1.7 a	.0 a	.0 a
Livestock	3.5 a	2.4 a	2.0 a	1.6 a	5.0 b	5.8 b
Total	64.8 a	72.8 b	33.8 c	67.4 a	70.1 a	33.4 b

Forage utilization level

[1] Damage was determined from the overall vigor of the tree seedlings. Substantial damage percentages included tree seedlings in vigor classes 3 or 4, as described in the appendix.

[2] Actual utilization of range forage from field measurements.

[3] Different letters indicate significant differences among utilization levels. The analysis was conducted using the arc sine $\sqrt{\text{percent}}$ transformation.

Livestock damage was significantly greater at the higher utilization levels, with 5.8 percent damage occurring at the high-utilization level and 5.0 percent damage occurring on the intermediate-utilization level, as compared to 1.6 percent damage at the light-utilization level.

Overall damage was greatest to western white pine on study sites receiving light and intermediate grazing intensities. Like ponderosa pine, most of the damage was caused by pocket gophers. The least amount of damage occurred on the study site that received high utilization.

Hume Creek

Grazing intensity appeared to have little influence on direct damage to ponderosa pine at Hume Creek (table 3). The greatest differences in damage observed were a result of wildlife- and nonanimal-related factors, with 12.5 percent damage for nonanimal at the low-utilization level as compared to 2 percent damage at high utilization. Wildlife caused 6.1 percent damage at high utilization, with 1.2 percent damaged at the moderate-utilization level. Significant differences were found in damages caused by livestock, with no damage at the low-utilization level and 2.7 percent damage at the high-utilization level. Also no significant differences were detected in the total number of ponderosa pine damaged at Hume Creek, with 11.3 percent to 15.1 percent damage observed among the grazing intensities.

Significant differences in damage to western white pine were observed among the three grazing intensities. Pocket gophers caused the greatest damage (7.9 percent) in the moderate-utilization level, with 0.3 percent damage observed in the low-utilization level. Wildlife caused 6.1 percent damage in the high-utilization level and 1.4 percent damage in the low-utilization level. Livestock damaged 3.8 percent of the western white pine seedlings and 0.3 percent of the trees in the low level of utilization. Overall the most damage to western white pine occurred under high and intermediate levels of utilization, with 19.2 percent total damage at high grazing intensity as compared to 7.5 percent damage at low utilization.

Table 3—Percentage of trees to incur damage[1] or mortality at Hume Creek site, for three forage utilization levels: low, 22 percent;[2] mid, 41 percent; high, 68 percent

Damage agent	Ponderosa pine			Western white pine		
	Low	Mid	High	Low	Mid	High
Nonanimal	12.5 a[3]	5.4 b	2.0 b	5.5 a	3.2 a	2.5 a
Gopher	.6 a	2.5 ab	3.4 b	.3 a	7.9 b	6.8 b
Big game	2.0 a	1.2 a	6.1 b	1.4 ab	3.3 a	6.1 b
Livestock	.0 a	2.2 b	2.7 b	.3 a	.6 a	3.8 b
Total	15.1 a	11.3 a	14.2 a	7.5 a	15.0 b	19.2 b

Forage utilization level

[1] Damage was determined from the overall vigor of the tree seedlings. Substantial damage percentages included tree seedlings in vigor classes 3 or 4, as described in the appendix.

[2] Actual utilization of range forage from field measurements.

[3] Different letters indicate significant differences among utilization levels. The analysis was conducted using the arc sine $\sqrt{\text{percent}}$ transformation.

DISCUSSION AND CONCLUSIONS

All sites considered together, direct damage from livestock was minimal. This was most apparent on the Indian Springs study site where rotational grazing management is practiced. There, direct grazing damage to both Douglas-fir and ponderosa pine was negligible. In addition, when rotational grazing is practiced, damage to tree seedlings was not found to be significantly different among utilization levels. In contrast, at Tee Meadows and Hume Creek, where rotational grazing is not practiced on the high-utilization sites, overall damage was greater. Higher grazing intensities appear to increase the potential for significant damage, and the accumulative effect of continuous and heavy grazing could be substantial in later years.

The amount of seedling damage from big-game animals was similar to that from livestock where terrain did not limit livestock movement. On the Hume Creek and Tee Meadow sites, livestock and big-game damage patterns were similar. On these sites, terrain did not limit either livestock or big-game movement. Meanwhile at Indian Springs, the greatest damage from big-game animals occurred on the light-utilization level, where elk and deer used scalped planting sites as "stair steps" on terrain too steep for livestock use. Terrain or steepness of slope could possibly be used as a controlling factor in minimizing livestock damage. Cutting units could possibly be designed to take advantage of slope conformation to control livestock damage.

Nonanimal damage also appeared to be related to grazing intensity on the Indian Springs site, with the greatest damage to tree seedlings occurring on the high-utilization site. This could be the result of past grazing history; however, it was observed that the soils on areas of steep topography were more developed than on areas of gentle-to-moderate terrain. This phenomenon, which resulted in poorer planting conditions for tree seedlings, may be a result of the mass wasting that has occurred on areas of steep topography, which routed talus material around large rock outcrops. While the remnants of these rock outcrops still exist and provide attractive areas for grazing animals, they are also sites that have had less opportunity for soil development. Because of these conditions, the potential for injury or mortality to tree seedlings from nonanimal and animal sources is higher than on the steeper, more favorable sites.

Pocket gophers were the greatest cause of tree damage in the study. It appeared that the greatest damage occurred on sites receiving the least grazing, where over half of the damage occurred aboveground during the growing season. The most favorable habitat for pocket gophers existed on the sites receiving moderate or light levels of utilization. The forbs and grasses provided adequate cover for ease of animal movement, as well as ample food for gopher population buildups. The scalps used for planting on the low-utilization sites provided areas for pocket gophers to begin and end tunnels. Thus pocket gopher damage both above and below ground was more extensive on the sites to receive intermediate to low levels of utilization.

On sites receiving moderate to heavy grazing intensities, pocket gopher damage was confined to the underground portion of the tree seedlings. There appears to be a relationship between the amount of ground cover and the amount of aboveground rodent damage. Sites receiving moderate-to-high grazing intensities appeared to be less conducive for pocket gopher movement, thus incurring less aboveground damage.

At the end of 1 year, results from this study indicate that the intensity of livestock use can influence tree seedling establishment and mortality. While the effects of grazing management practices on tree seedling establishment were not tested, it was observed that there was less damage and mortality where rotation grazing was practiced. In addition, it appears that intensity of livestock grazing may influence rodent damage. If in fact there is a relationship between ground cover and rodent damage, prudent livestock grazing may provide an opportunity to further reduce rodent damage. This possibility warrants further investigation.

REFERENCES

Adams, A. N. Sheep and cattle grazing in forests. Journal of Applied Ecology. 12: 143-152; 1975.

Arnold, F. F. Descriptions of sections and subsections of that portion of the Northern Rocky Mountain physiographic province containing the Idaho Batholith: Appendix B of the Idaho Batholith source book. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region; 1975. 342 p. and map.

Austin, M. E. Major land resource regions and major land resource areas of the United States. Agriculture Handbook 296. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service; 1972. 82 p.

Clary, W. P.; Kruse, W. H.; Larson, F. R. Cattle grazing and wood production with different basal areas of ponderosa pine. Journal of Range Management. 28: 434-437; 1975.

Cooper, S. K.; Neiman, K. E.; Steele, R. Forest habitat types of northern Idaho. Missoula, MT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1985. 210 p. Review draft.

Edgerton, P. J. The effects of cattle and big game grazing on a ponderosa pine plantation. Research Note PNW-172. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1971. 8 p.

Eissenstat, D. M.; Mitchell, J. E.; Pope, W. W. Trampling damage by cattle on northern Idaho forest plantations. Journal of Range Management. 35: 715-716; 1982.

Hedrick, D. W. Grazing mixed conifer forest clearcuts in northeast Oregon. Rangeman's Journal. 2: 6-9; 1975.

Kingery, J. L. Research response to forestland grazing needs on public lands of the northern Intermountain region. In: Proceedings, forestland grazing symposium; 1983 February 23-25; Spokane, WA. Pullman, WA: Washington State University; 1983: 85-87.

McLean, A.; Clark, M. B. Grass, trees, and cattle on clearcut-logged areas. Journal of Range Management. 33: 213-217; 1974.

Mitchell, J. E.; Eissenstat, D. M.; Irby, A. J. Forest grazing—an opportunity for diplomacy. Journal of Range Management. 4: 172-174; 1982.

Tisdale, E. W. Grazing of forest lands in northern Idaho and adjacent areas. In: Proceedings, Society of American Foresters. Washington, DC: Society of American Foresters; 1961: 150-153.

U.S. Department of Agriculture, Forest Service. Range analysis handbook. Forest Service Handbook 2209.21, R-6. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region; 1984.

U.S. Department of Agriculture, Forest Service. Timber management handbook. Forest Service Manual 2400, Supplement No. 257, R-4. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region; 1982.

Wellner, C. A. [Timber Management Research memorandum.] 1969 April 21. On file at: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Moscow, ID.

APPENDIX: TREE DAMAGE CODE KEY

Source 0. No damage

Source 1. Animal damage

Type 1. Livestock (cattle)
2. Deer
3. Elk
4. Pocket gopher
5. Porcupine
6. Big game (deer + elk)
7. Grazing/browsing animals
8. Small aboveground rodent
9. Other

Damage 1. Trampling

Type 1. Stem scarring	cm
2. Growth abnormality	degree
3. Bud or stem broken	cm lost
4. Trauma	degree
5. Shade card caused growth abnormality	degree
6. Shade card caused bud/stem breakage	degree

Damage 2. Browsing

Type 1. Terminal bud damaged or removed	cm
2. Terminal bud and portion of main stem damaged or removed	cm
3. Lateral bud damaged or removed	cm
4. Lateral bud and portion of main stem damaged or removed	cm
5. Root damaged or removed	pct
6. Entire tree removed	—
7. Needles removed	pct
8. Terminal and lateral buds damaged or removed	cm

Damage 3. Bark removal

Type 1. Girdling (>25% circumference)	pct
2. Stripping (>25% circumference)	cm

Damage 4. Burial

Type 1. >25% buried
2. Growth abnormality due to burial

Source 2. Nonanimal damage

Type 1. Drought/desiccation
2. Stock quality
3. Planting and handling
4. Sun scald
5. Frost
6. Unknown
7. Snow
8. Shade card
9. Water

Damage 1. Terminal bud

Type 0. Terminal bud damaged	cm
1. Terminal bud dead	—

Damage 2. Lateral bud

Type 0. Lateral bud damaged	cm
1. Lateral bud dead	—

Damage 3. Terminal and lateral buds

Type 0. Terminal and lateral buds damaged	cm
1. Terminal and lateral buds dead	—

(con.)

APPENDIX: (Con.)

Damage 4. Needles	
Type 0. Needles missing	pct
1. Needles dead	pct
Damage 5. Roots	
Type 0. Entire root	—
1. J-root	—
3. Air gap	—
Damage 6. Entire aboveground portion	
Type 0.	
1. Growth abnormality	degree
Source 3. Unknown source of damage	
Damage 1. Needles missing	pct
Damage 2. Needles dead	pct
Damage 3. Terminal bud dead	—
Damage 4. Lateral bud dead	—
Source 4. Insect damage	
Type 1. Spruce budworm	
Damage 1. Terminal bud	
Type 0. Damage	degree
1. Removal	cm
Damage 2. Lateral bud	
Type 0. Damage	degree
1. Removal	cm
Damage 3. Needles	
Type 0. Defoliation	pct

Notes:

1. Vigor is based upon percent needles chlorotic, dead or missing.
    1. 0 - 25 percent
    2. 25 - 50 percent
    3. 51 - 75 percent
    4. 76 - 99 percent
    5. 100 percent (dead)
2. Centimeters of bud or stem removed determined by "reconstruction."
3. Degree is a subjective evaluation: 1 = minimum, 4 = maximum.

Kingery, James L.; Graham, Russell T.; White, Jeffrey S. Damage to first-year conifers under three livestock grazing intensities in Idaho. Research Paper INT-376. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1987. 8 p.

Animal and nonanimal damage to first-year tree seedlings was compared under different cattle grazing intensities in three habitat types in northern and central Idaho. Because of differences in cultural practices and physical conditions, the relationship between grazing intensity and total tree seedling mortality and damage varied between study areas.

KEYWORDS: forest grazing, regeneration, animal damage

INTERMOUNTAIN RESEARCH STATION

The Intermountain Research Station provides scientific knowledge and technology to improve management, protection, and use of the forests and rangelands of the Intermountain West. Research is designed to meet the needs of National Forest managers, Federal and State agencies, industry, academic institutions, public and private organizations, and individuals. Results of research are made available through publications, symposia, workshops, training sessions, and personal contacts.

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